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ABSTRACT

Motlow State Community College (MSCC) in Tullahoma, Tennessee, received a federal grant to develop and implement an electronics computer-assisted instruction (CAI) classroom and an electronics computer-controlled laboratory (CCL). A portion of a complete CAI/CCL electronics curriculum developed by NIDA Corporation was developed. implemented, and evaluated at MSCC for use in teaching a total of 504 competency-based objectives in courses in direct current (DC) circuits, alternating current (AC) circuits, and digital circuitry. MSCC is now in its fourth year of using the CAI/CCL system and regularly offers basic electronics classes covering the 504 objectives through a combination of the CAI/CCL, a textbook developed by NIDA Corporation, and daily lectures. The MSCC program features 12 IBM-compatible personal computers that are each connected to a NIDA 130C trainer and that each have DC, AC, analog, and digital software and supporting experiment cards. The CAI/CCL system generates tests for almost every lesson that are instantly graded by the system. The system software has proved nearly error free and the NIDA trainers have been very dependable. Student satisfaction with and success in the program have been near the 100% level. (MN)

THE DEVELOPMENT, IMPLEMENTATION, AND EVALUATION OF AN ELECTRONICS CURRICULUM USING COMPUTER-ASSISTED INSTRUCTION/COMPUTER-CONTROLLED LABORATORY AT MOTLOW STATE COMMUNITY COLLEGE TULLAHOMA, TENNESSEE

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INTRODUCTION

Motlow State Community College (MSCC) in Tullahoma, Tennessee, received a Title III Federal grant to begin development and implementation of an electronics computer-assisted instruction (CAI) classroom and an electronics computer-controlled laboratory (CCL). Seventy-one percent of first-time freshmen who entered MSCC in fall 1992 were not properly prepared for college classes and were required to take remedial or developmental classes, according to the Tennessee Higher Education Commission. A delivery system of CAI and CCL for the electronics technology classes that could allow students to progress through the coursework at varying rates while allowing easy access to repeat or review materials was considered to be advantageous to many of these students.

Improvements in computer technology has promoted rapid advances and innovations in CAI lessons. The computer hardware and software can be used to present instructional materials and to evaluate the student responses. The student can individually interact with the CAI materials and be directed almost step by step through laboratory fault-finding procedures using the CCL.

The use of CAI and CCL will emerge as a means of reaching a more diverse student population with the availability of individualized instruction so that students can gain mastery of the materials before proceeding to more advanced materials. With today's advances in computer technology and drastic reductions in the cost of this technology, CAI and CCL will become more demanded as results from research are proven and educational organizations become aware of their availability.

BACKGROUND

Improvements in advanced computer technology promote innovations in CAI lessons, therefore making CAI a much more feasible format for providing individualized training. Early attempts, which were little more than programmed learning exercises, have given way to sophisticated graphic displays with high resolution, color, animation, and even video images on the cathode ray tube (CRT) screens. Computers are merely instruments for providing CAI; and the effectiveness of the CAI lesson depends on the skill of the lesson author. Today, teachers and computers must work in concert to increase the effectiveness of the learning situation. When students use computers and have control over their personal learning agendas, they become more independent.

Since good fault-finding skills will help in producing a well-qualified technician, it is desirable to have CCL monitor the individual experiment and help each student study fault-finding procedures while being directed almost step by step

through the procedures under the direction of a microcomputer software program. CAI and CCL are media which are suited for presenting highly interactive instruction in the form of drills, simulations, and tutorials. With a drill, students practice materials already learned in order to strengthen or maintain knowledge; with a simulation, students use a model that approximates a real work situation as locating a defective component in an electronic circuit; and with a tutorial, students study theoretical concepts similar to using a textbook but with built-in remediation supplied if a student needs this extra help. CAI and CCL also respond to individualized needs by informing the student whether each answer is right or wrong, presenting additional practice as needed, and allowing the speed of presentation to be adjusted by the student.

Since MSCC's first basic electronics course has no stated prerequisite other than a high school mathematics background, the students in the basic electronics classes have always been a very heterogeneous group. With various technical experiences and with their lack of electronics experience, these students usually can progress at greatly different rates through the materials; but the traditional lecture class restricts the speed with which students can proceed through the materials.

Some students need to repeat materials or to participate in drills or simulations to better grasp the concepts. Some students can benefit from special tutorials or remediation materials if these could be provided on an individual basis. Also, the need of additional instructional time, which is not always available, impedes the progress of some students in their study of technical materials. Finally, the various learning styles and specialized needs of these basic electronics students created the need for a better educational delivery system such as CAI.

One of the most significant differences between the use of computer-assisted instruction and traditional classroom lectures is that the computer enables students to interact with the instructional materials. Competency-based education is then more easily implemented with CAI since each student can be expected to master each measurable objective before advancing to another.

CAI provides the teacher with a vehicle for individualized instruction for all students, not just for the few at either end of the spectrum of scholastic aptitude. Not only does CAI allow individualized learning but at least two other learning principles are applied using CAI. Learning is improved by the quick feedback of information to the student; also, the active participation by the learner is much more conducive to learning than the traditional passive role.

Finally, different feedback messages or responses in CAI lessons should be provided depending on the student's response. The effectiveness of feedback is a basic tenet of instructional theory that has been demonstrated countless times by educational

researchers, beginning with the classic learning studies by Thorndike. Frequent and consistent use of feedback is strongly promoted in today's textbooks on teaching and training.

CAI/CCL

NIDA Corporation has developed a complete CAI/CCL electronics curriculum for use on IBM compatible personal computers. A portion of this system has been fully developed, implemented, and evaluated at MSCC for direct current circuits, alternating current circuits, and digital circuitry. The 504 competency-based objectives for these three courses are attached.

I feel that the following fifteen characteristics should be present in any effective CAI/CCL system. The NIDA CAI/CCL system offers each of these features.

1. Branching so that each student can take one or more different tracks based on the student's responses to questions.

2. Remediation so that additional study of certain materials is available when needed by some students to provide a better understanding of the lesson objectives.

3. Flexibility so that the instructor can choose from a variety of instructional treatments as simulation, drill and practice, and tutorials.

4. Self-pacing so that students can proceed at a pace appropriate for their individual learning styles.

5. Graphics and audio so that difficult and abstract concepts can be better presented to help the student build comprehension in these areas that are difficult to teach by other instructional techniques.

6. Simulation so that students can have otherwise unattainable experience to which they can react, control, or become a part of.

7. Complete instructional objectives so that the specific objectives required in a curriculum are covered within the CAI lessons.

8. Proper organizational sequencing of lessons to teach skills so that as the lesson progresses, skills learned earlier continue to be used and to strengthen the background for learning increasingly more difficult skills.

9. Manageable steps throughout the lesson so that the student can accomplish and master each step or assignment before advancing to the next materials.

10. Instructional background as definitions and procedures for each lesson is presented either in the previous lessons or at the beginning of the specific lesson.

11. Well-designed feedback which anticipates and addresses students' responses and adds depth to the instruction and additional meaning to the questions that are asked.

12. Accuracy and correctness of all materials used so that students will not be misled by erroneous statements.

13. Creation of interest and motivation so that students have a desire to continue to use the CAI lessons to achieve and to see their progress.

14. Well-written instruction materials with clarity, good grammar, and structure so that they can serve as a model of good writing for the students.

15. Help screens that are easily available so that different aspects of the operation of the lessons are explained and additional directions and procedures that might be needed for specific screens are accessible to the students.

Again, NIDA Corporation offers all of these features with their CAI/CCL equipment!!!

SYSTEM FEATURES

1. MSCC is now in its fourth year of use of the CAI/CCL system.

2. MSCC has 12 IBM-compatible personal computers, each connected to a NIDA 130C trainer and each having the DC, AC, Analog, and Digital software and supporting experiment cards.

3. MSCC regularly offers the Basic Electronics classes covering the attached 504 objectives with the student using the CAI/CCL and a NIDA textbook and having daily lectures.

4. The CAI/CCL system generates tests for almost every lesson which is then instantly graded by the system. Final exams are also provided and graded by the system.

5. NIDA CAI software is almost error free.

6. NIDA 130C trainers are very dependable and very well protected against circuit overloads.

7. NIDA fiberglass circuit cards are extremely durable.

RESULTS

1. Student satisfaction is near 100%.

2. Student success is near 100%.

3. Students take so many tests (one test after most lessons) that their test taking skills improve.

4. Student reading skills improve.

5. Student learns to work independently and usually reviews materials before asking for assistance.

6. Each lesson can be aborted or restarted as the student desires.

7. This system motivates the student to succeed.

8. Mastery is expected and most students desire to achieve mastery.

9. Test preparation and test grading is almost eliminated.

10. System works <u>best</u> if an electronics teacher is on-site for any questions and further explanations.

STUDENTS' COMMENTS

"The CAI system currently being used to teach Basic Electronic I is a welcome change from traditional teaching methods. It allows the student to review key points of the lesson. It uses graphics which will reinforce the lesson. And finally the test console allows the student hands-on experience which is the best method of teaching."

"I like this system because it is simple to use. It is good if you are a slow learner because you can review the objectives as many times as often unlike a lecture. If you miss a lecture you are behind. If you have the training system you can catch up by the computer lessons. This is very versatile because you can do this on your own at your own time without an instructor. I think that it is a great idea."

"I like the instant feedback that allows you to know your weak areas.

It also allows a flexible schedule.

It enables going at one's own pace.

It eliminates the time consuming element of breadboarding."

DEFINITIONS OF TERMS

Alternating current is electrical current that reverses direction at a regular rate.

Computer-assisted instruction (CAI) is the use of modern computer technology to provide individualized instruction in the form of drill and practice, simulations, and tutorials.

Computer-controlled laboratory (CCL) is the use of modern computer technology to monitor individual laboratory experiments and to help each student study fault-finding procedures while being directed almost step by step. A CAI lesson can be designed to place all management decisions under computer control.

Competency-based education is a methodology that identifies the objectives that should be mastered and facilitates learning by encouraging each student to master each measurable objective before advancing to another.

Digital electronics is electrical circuits involving only two voltage levels for all input and output signals.

Direct current is electrical current that flows in only one direction.